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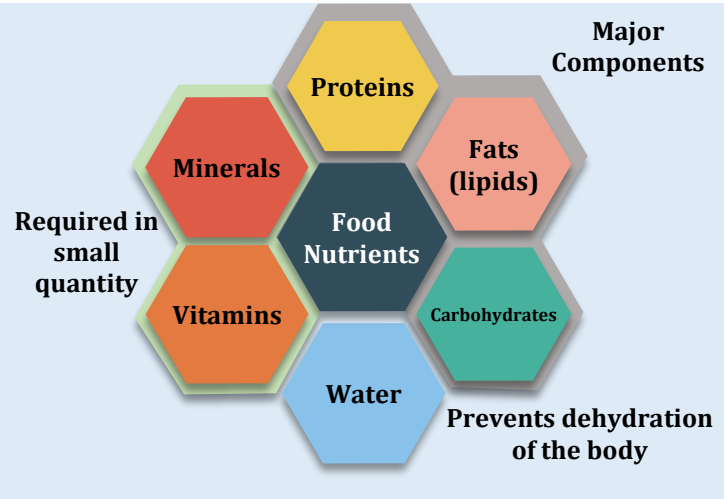
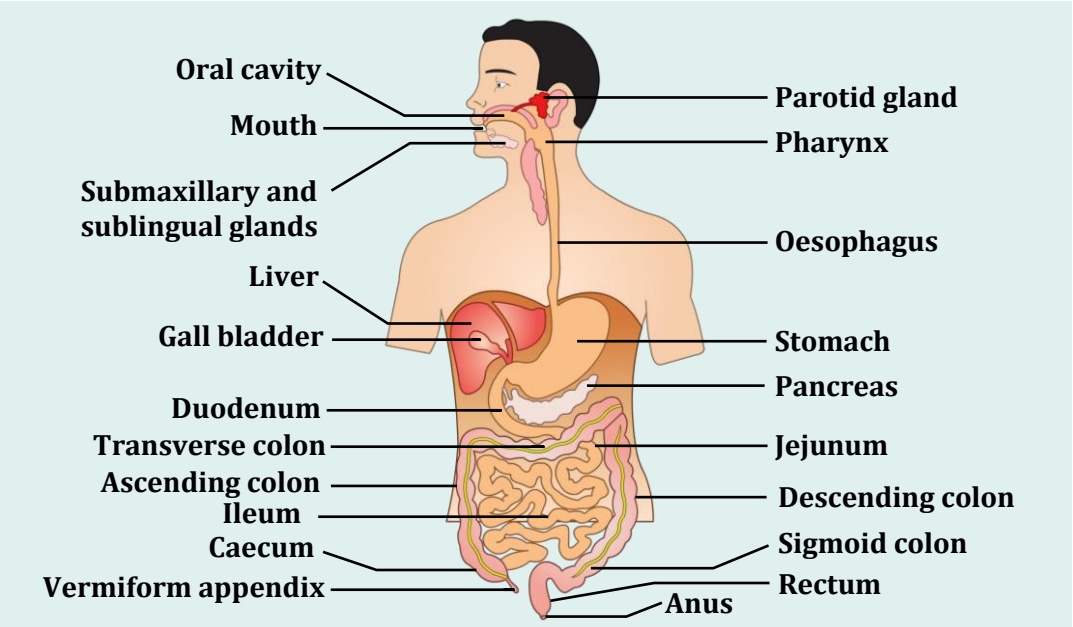
01 Digestion and Absorption

1. Introduction :

- **Food** is one of the **basic requirements** of all living organisms.
- The **major components of our food** are **carbohydrates, proteins** and **fats**.
- Vitamins and minerals are also required in small quantities.
- Food provides energy and organic materials for growth and repair of tissues. The **water** we take in plays an important role in metabolic processes and also prevents dehydration of the body.





General Organisation of the Human Digestive System

- Biomacromolecules in food cannot be utilised by our body in their original form. They have to be broken down and converted into simple substances in the digestive system. This process of conversion of complex food substances to simple absorbable forms is called **digestion** and is carried out by our **digestive system** by **mechanical** and **biochemical methods**.

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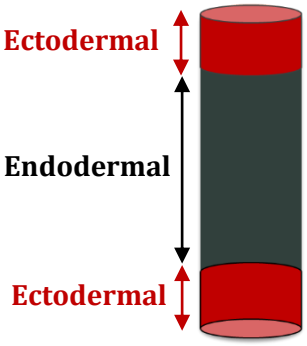
Origin of Alimentary Canal :

- The alimentary canal is tubular structure which extends from mouth to anus.
- It develops from ectoderm & endoderm.

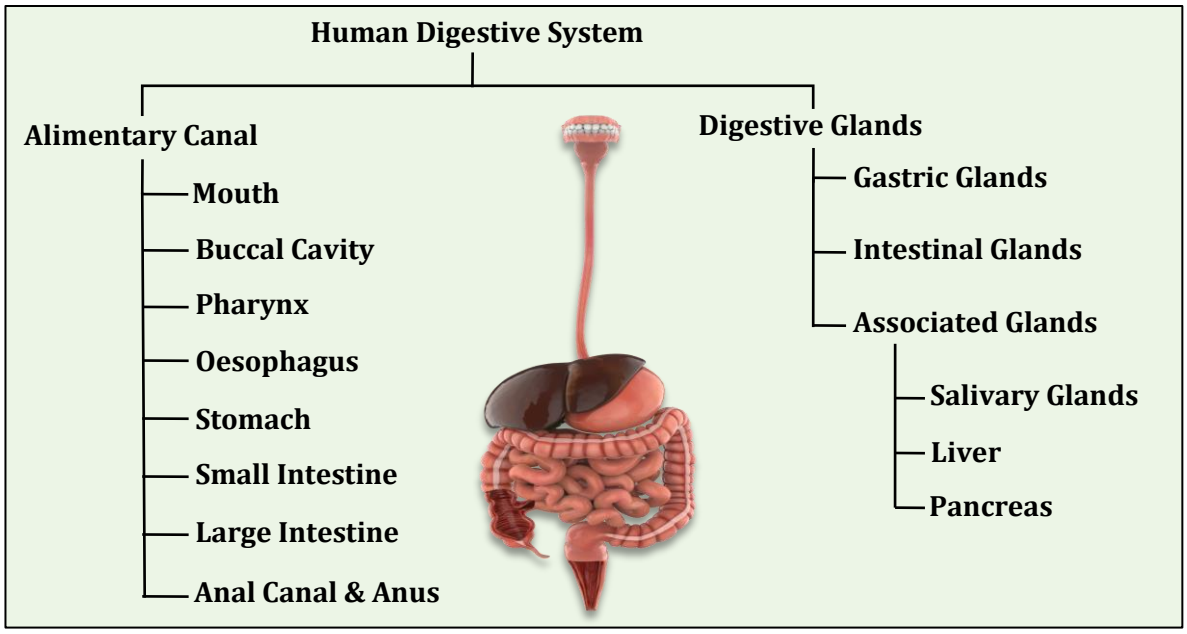
Ectoderm - upto hard palate

Endoderm - from soft palate to rectum

Ectoderm - from anal canal to Anus



2. Digestive System :



(A) Alimentary canal :

- The alimentary canal begins with an anterior opening – the **mouth**, and it opens out posteriorly through the **anus**.

(1) Mouth and Buccopharyngeal Cavity :

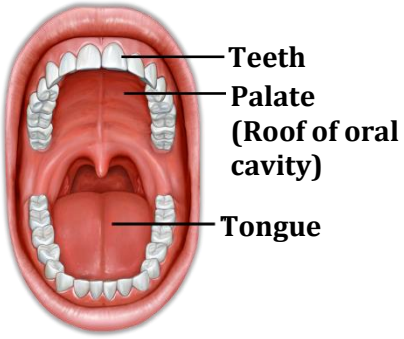
- Mouth is a horizontal transverse slit like aperture which is surrounded by upper and lower lip.
- The mouth leads to the **buccal cavity** or **oral cavity**.

(i) Buccal vestibule

- The space between the gums and cheeks where the food is stored temporarily.

(ii) Oral cavity

- The oral cavity has a number of **teeth**, a muscular **tongue** and **palate**.
- It is inner & central part which is surrounded by upper and lower jaw.
- Lined by non-keratinized stratified squamous epithelium.
- **Upper Jaw is fixed** and **lower jaw is movable**.



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(iii) Palate - Roof of buccal cavity is called **palate**.

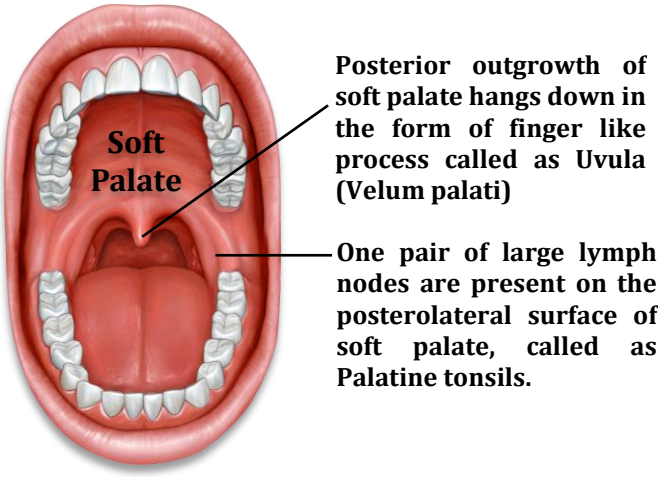
- **Palate is differentiated into two parts:**

(a) Hard Palate –

- It is the **anterior part** of the palate.
- It is made up of maxilla and palatine bone in human.
- On the ventral surface of hard palate, some projections or transverse ridges are present which are called **palatine rugae**.
- These rugae prevent slippage of the food from buccal cavity during mastication.
- These rugae are well developed in carnivorous animals.

(b) Soft Palate –

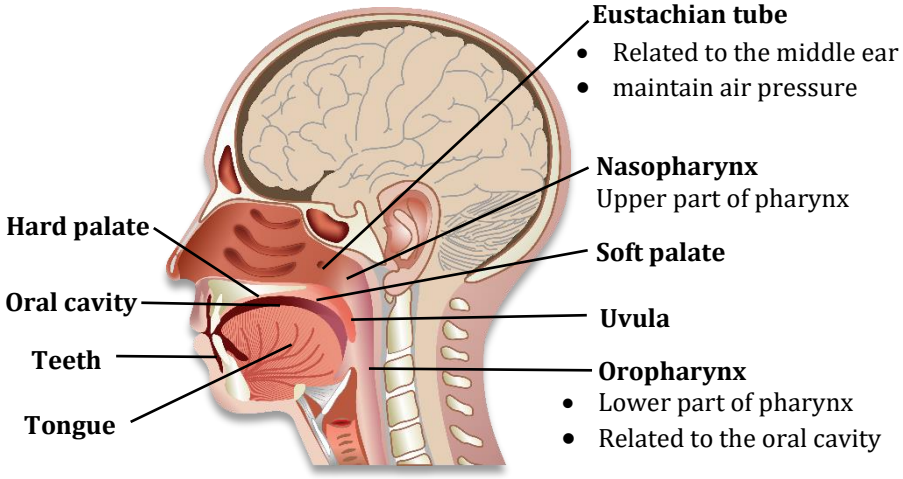
- It is the **posterior part** of palate.
- The posterior outgrowth of soft palate which hangs down in the form of finger like process called as **Uvula or Velum palati**.
- On the dorsal side of uvula one pair **internal nasal pores** are present.
- Uvula covers the opening of internal nasal pores during ingestion of food, so food particle cannot move inside nasal chamber.
- One pair of large lymph node is present on the posterolateral surface of soft palate, called as **Palatine tonsil** or Tonsils.
- Soft palate is situated in the pharynx and pharynx is divided into two parts.
- Upper part of pharynx is called **Nasopharynx** which is related to the nasal chamber.
- The lower part of pharynx is called **Oropharynx** which is related to the oral cavity.


Soft Palate
Posterior outgrowth of soft palate hangs down in the form of finger like process called as Uvula (Velum palati)
One pair of large lymph nodes are present on the posterolateral surface of soft palate, called as Palatine tonsils.

- One pair of **openings of Eustachian tube** is present in the nasopharynx.
- This Eustachian tube is **related to the middle ear** : It maintain air pressure.
- The oral cavity leads into a short pharynx which serves as a common passage for food and air.

(2) Pharynx :

- The oesophagus and the trachea (wind pipe) open into the pharynx.
- A cartilaginous flap called epiglottis prevents the entry of food into the glottis – opening of the wind pipe – during swallowing.



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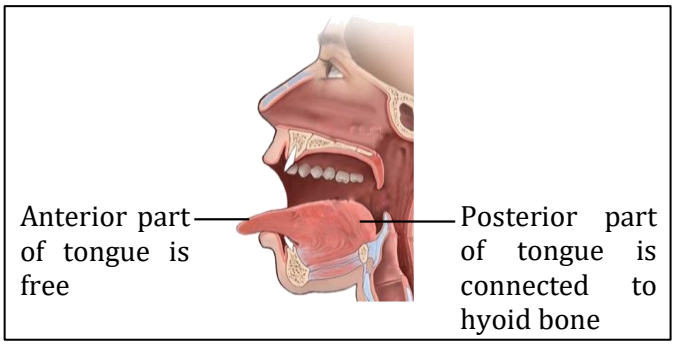
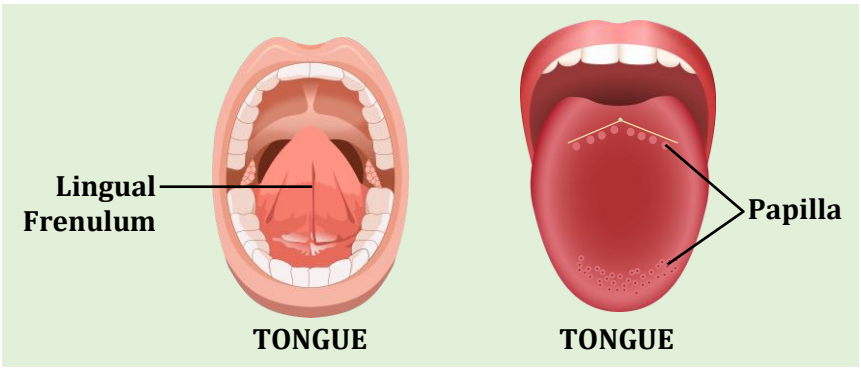
(3) Tongue :

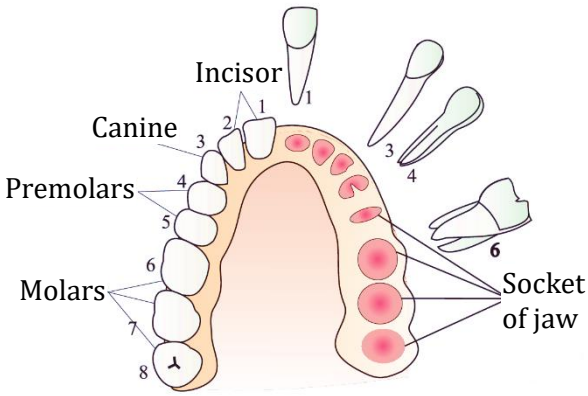
- The tongue is a **freely movable muscular organ** attached to the floor of the oral cavity by the **frenulum**.
- The upper surface of the tongue has small projections called **papillae, some of which bear taste buds**.





(4) Teeth :

- Teeth are **ectomesodermal in origin**.
- In human beings three basic features of teeth are **thecodont, diphyodont** and **heterodont**.
- Each tooth is **embedded in a socket of jaw** bone. This type of attachment is called **thecodont**.
- Majority of mammals including human being forms **two sets of teeth during their** life, a set of temporary milk or deciduous teeth replaced by a set of permanent or adult teeth. This type of dentition is called **diphyodont**.
- An adult human has 32 permanent teeth which are of **four different types (Heterodont dentition)**, namely, incisors (I), canine (C), premolars (PM) and molars(M).



- Four types of teeth found in mammals are –

Incisors – These are long, chisel like teeth for gnawing the food. Eight in number.

Canines – These are sharp pointed teeth meant for tearing and shredding the food. Canines are most developed in carnivorous animals.

(Incisors and canines are called smiling teeth.)

Pre molars – These teeth are meant for chewing and crushing of food. They are triangular in shape.

Molars (Cheek teeth) – These are also meant for chewing & crushing of food. They are rectangular in shape.

(Molars and premolars are called cheek teeth.)

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Human dentition :

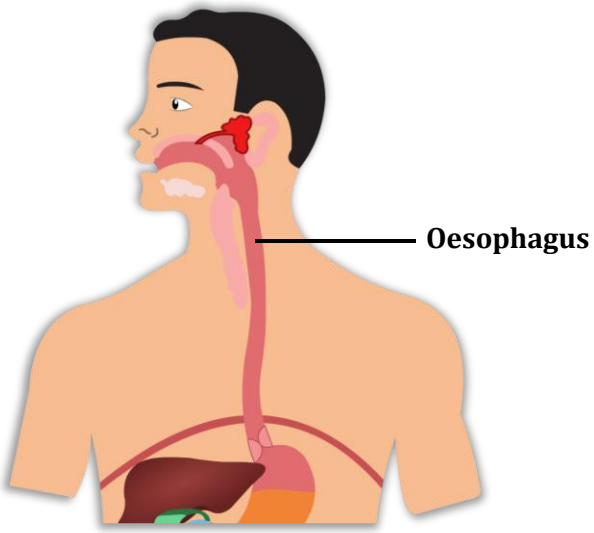
- Arrangement of teeth in each half of the upper and lower jaw in the order I, C, PM, M is represented by **dental formula** which in human is $\frac{2123}{2123}$.
- The hard chewing surface of teeth, made up of **enamel**, helps in the mastication of food. Enamel is the hardest known substance of animal kingdom.

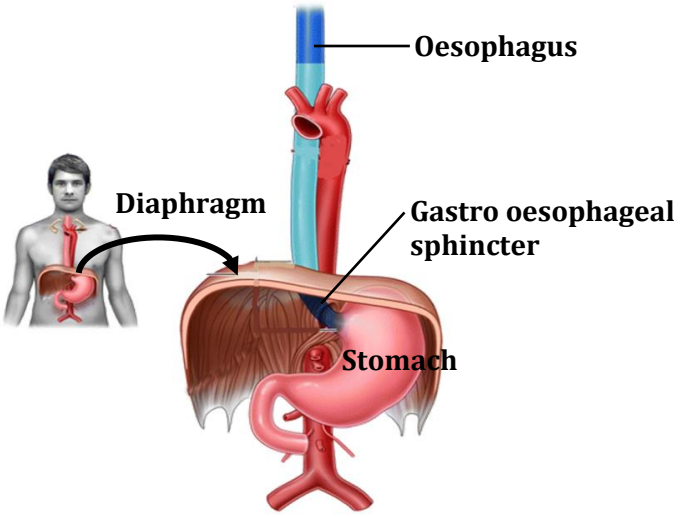
Dental formula :

$\frac{2123}{2123}$	$\frac{2122}{2122}$	$\frac{2102}{2102}$
ADULT	17 Yr. OLD	INFANT

(5) Oesophagus :

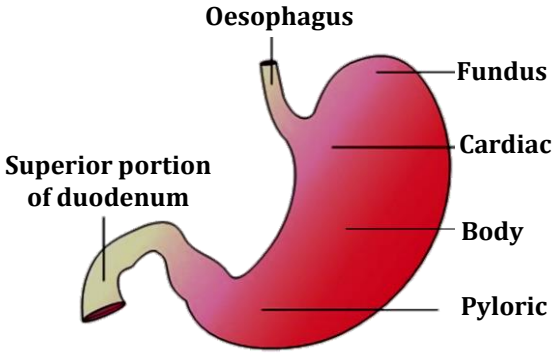
- Two apertures are found in Buccopharyngeal cavity.
- Dorsal aperture is called **gullet** which continues into **oesophagus**.
- Ventral aperture is called **glottis** which continues into **larynx**.
- The **oesophagus** is a thin, long tube which extends posteriorly passing through the neck, thorax and diaphragm and leads to a **"J" shaped** bag like structure called **stomach**. A muscular sphincter **(gastro-oesophageal)** regulates the opening of oesophagus into the stomach.





(6) Stomach :

- It is located in the upper left portion of the abdominal cavity.
- It is the widest part of alimentary canal.
- It is a bag like muscular structure, J shaped in empty condition.
- The stomach contains four parts (Cardiac, Fundus, Body, Pylorus)



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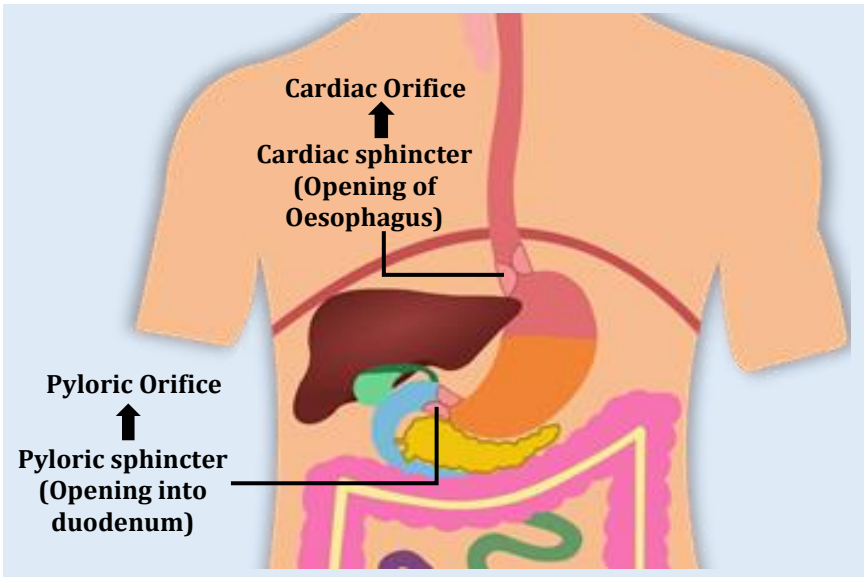
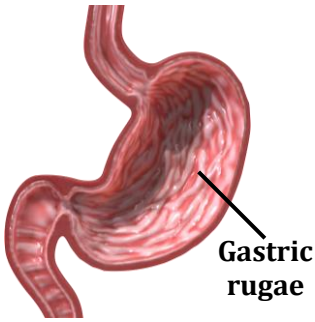
It has two orifices (opening)

(i) Cardiac orifice is joined by the lower end of the oesophagus.

(ii) Pyloric orifice opens into the duodenum.



- In empty stomach numerous temporary longitudinal folds are found in mucosa of stomach called rugae. They disappear when stomach is distended.
- **Gastric Glands:-** These are numerous microscopic, simple branched tubular glands formed by the invagination of epithelium (mucosa) in the stomach. The following types of cells are present in the epithelium of the gastric glands.
- Mucous neck cells
- Oxyntic cells or parietal cells
- Chief cells or Peptic cells or Zymogen cells



Consist of 3 types of cells

- Mucous cells ---secrete---→ mucus - protect inner lining of stomach from action of HCl
- Parietal cells → Castle Intrinsic Factor - helps in absorption of vitamin B_{12}.
  (Oxyntic cells) → HCl (pH = 1.8 – 3.2)
  - (1) inactivate ptyalin
  - (2) Kill bacteria present in bolus
  - (3) Convert inactive enzymes into active enzymes
  - (4) Provide acidic medium in stomach
  - (5) Softens food particles
- Peptic cells /Chief cells/ Zymogen cells
  - Gastric lipase - convert 1% emulsified fats already present in our food into fatty acids and monoglyceride
  - Pepsinogen $\xrightarrow{HCl}$ Pepsin
  - Prorennin (In infants) $\xrightarrow{HCl}$ Rennin

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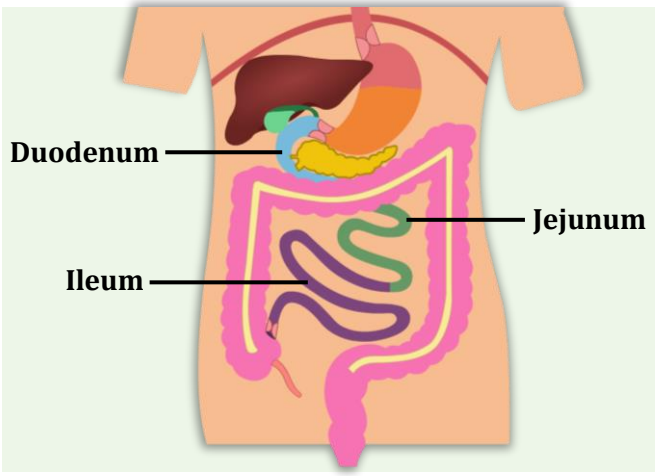
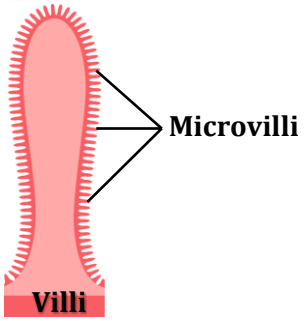
(7) Small Intestine :

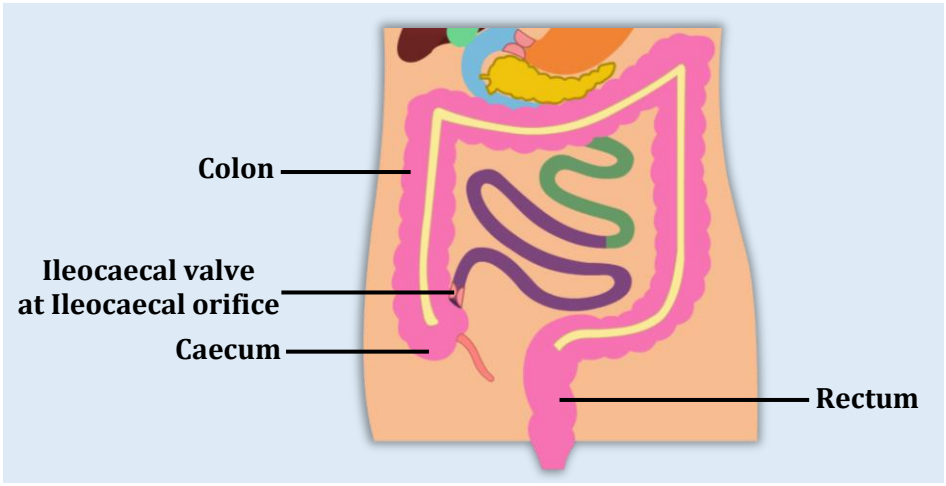


- Small intestine is distinguishable into three regions.
  (i) a 'C' shaped duodenum,
  (ii) a long coiled middle portion jejunum
  (iii) a highly coiled ileum.
- The opening of the stomach into the duodenum is guarded by the **pyloric sphincter**.
- Function of small intestine is to digest and absorb nutrients in to the body, hence to increase the absorptive surface area the following modification are observed
  (a) Greater length of the intestine.
  (b) Villi and microvilli.



(8) Large Intestine :

- Ileum opens into the large intestine.
- Large intestine is larger in diameter than small intestine.



- It consists of– (i) Caecum (ii) Colon (iii) Rectum

(i) Caecum:-

- Caecum is a small blind sac which hosts some symbiotic microorganisms.
- Lower end of the ileum opens on the Posteromedial aspect of the Ileo-caecal junction guarded by Ileocaecal valve.
- About 2 cm below the ileocaecal orifice, a worm like structure arises from the caecum called as vermiform appendix.
- It is a vestigeal organ.
- Caecum open into colon.

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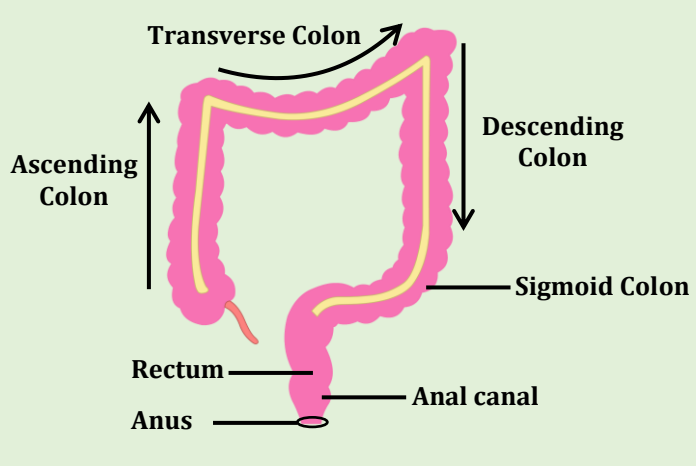
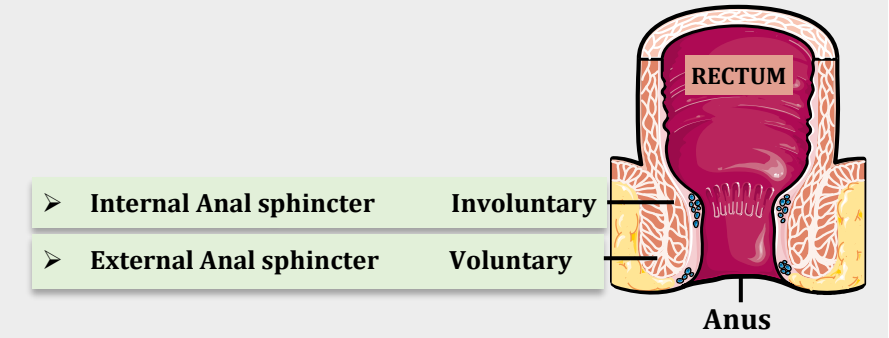
(ii) Colon:-

- Caecum continues in colon, which is the middle part of large intestine.
- The longitudinal muscle coat forms three ribbon like bands called Taeniae coli.
- Due to the presence of taeniae, pouch like structure develops in Lumen of colon called as Haustra.
- Haustra increases surface area of large intestine for absorption of water.



(iii) Rectum:-

- Colon open into a small bag like structure called rectum. It acts as a storage for faeces.



Anal canal :

- Rectum opens into a canal called Anal Canal and its external orifice is called Anus.
- Anal canal is guarded by two sphincters called.

BEGINNER'S BOX-1 — ANATOMY OF ALIMENTARY CANAL

1. Dental formula of adult human is -

(1) $\frac{2123}{2123}$ (2) $\frac{2123}{2122}$ (3) $\frac{2123}{2124}$ (4) $\frac{2132}{2132}$

2. In Colon, constrictions of its wall form a series of small pockets called-

(1) Haustra
(2) Crypts of Lieberkuhn
(3) Zymogen cells
(4) Taeniae

3. pH of stomach in human is about-

(1) 7 (2) 1.8 (3) 8 (4) 11

4. Number of teeth which are monophyodont in man is-

(1) 4 (2) 22 (3) 32 (4) 12

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5. The cells of the epithelial lining in the vertebrate stomach are not damaged by HCl because of-
(1) Mucus secretion covering the epithelium
(2) Neutralization of HCl by alkaline gastric juice.
(3) HCl being dilute
(4) Epithelium being resistant to HCl

6. The structure which prevents entry of food into wind pipe during swallowing in mammals is-
(1) Larynx (2) Glottis (3) Epiglottis (4) Pharynx

7. Which of the following is a common passage in swallowing food and breathing?
(1) Pharynx (2) Larynx (3) Glottis (4) Gullet

8. The hardest part of the tooth is-
(1) Enamel (2) Dentine (3) Bone (4) Pulp

9. Types of teeth in human -
(1) Thecodont (2) Acrodont (3) Pleurodont (4) Homodont

10. Posterior part of soft palate, hangs down in pharynx, called-
(1) Palatine (2) Tonsils (3) Velum Palati (4) Jacobson's organ

11. Nasal chambers and buccal cavity are separated -
(1) By uvula (2) By palate (3) By tongue (4) None of these

12. Cheek teeth are-
(1) Incisors and Canines (2) Canines and Premolars
(3) Premolars and Molars (4) Canines and Molars

13. What do you mean by the process of digestion?
(1) Conversion of complex substances into simpler form
(2) Absorption of monomers by the body
(3) Conversion of monomers into polymers
(4) Absorption of water and food

14. What is frenulum?
(1) It is the fold by which tongue is attached to the floor of oral cavity
(2) It is uvula is present on pharyngeal wall
(3) It is tonsil like structure on the lateral walls of palate
(4) It is V-shaped furrow which divides the surfaces of tongue

15. Papilla are present on –
(1) cheeks (2) teeth (3) tongue (4) nasal chamber

16. Which part of tongue is connected by Hyoid bone?
(1) Anterior (2) Posterior (3) Lateral (4) Frontal

17. Which of the following is a small blind sac which hosts some symbiotic microorganisms?
(1) Rectum (2) Duodenum (3) Caecum (4) Colon

18. Which of the following is present between oesophagus and stomach–
(1) Ileocaecal valve (2) cardiac sphincter (3) gastric valve (4) pyloric sphincter

19. Vermiform appendix arise from-
(1) jejunum (2) ileum (3) caecum (4) colon

20. What is the shape of Duodenum?
(1) C-shaped (2) U-shaped (3) J-Shaped (4) O-Shaped

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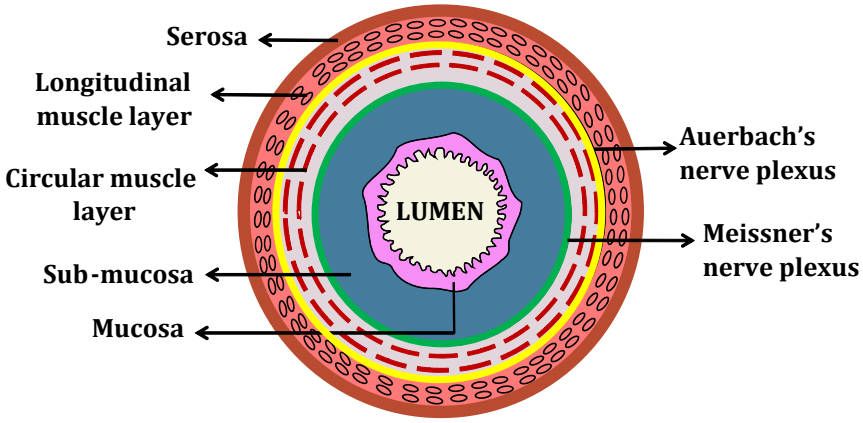
(B) Histology of Alimentary Canal :

- The wall of alimentary canal from oesophagus to rectum possesses four layers–

(i) Serosa **(ii) Muscularis**
(ii) Sub-mucosa **(iv) Mucosa**



(i) Serosa :

- It is outer most layer of gut.
- Serosa is made up of a thin **mesothelium** (epithelium of visceral organ / visceral peritoneum) with some connective tissue.
- It is called **tunica adventitia in oesophagus.**
- Tunica adventitia is made up of white fibrous connective tissue and areolar connective tissue.
- **Ommentum-** Outer most layer of stomach (Simple Squamous Epithelium + Fats + Lymph Tissue)

(ii) Muscularis (muscle layer) :

- Muscularis is formed by smooth muscles usually arranged into an inner circular and an outer longitudinal layer.
- Outer longitudinal smooth muscle.
- Inner circular muscle layer.
- An **oblique muscle** layer may be present in some regions **(Stomach).**
- **Thickest layer** is found in stomach (maximum peristalsis).
- **Thinnest layer** in rectum (minimum peristalsis).
- **Auerbach's Nerve plexus** (Control peristalsis).

(iii) Sub mucosa :

- Formed of loose connective tissues containing nerves, blood and lymph vessels.
- **Brunner's glands** (in submucosa of duodenum).
- **Meissner's Nerve Plexus** (Controls secretions).

(iv) Mucosa :

- Innermost layer lining the lumen of the alimentary canal.
- This layer forms irregular folds **(rugae)** in the stomach and small finger-like foldings called **villi** in the small intestine.
- The cells lining the villi produce numerous microscopic projections called microvilli giving a brush border appearance.

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- These modifications increase the surface area enormously.
- Villi are supplied with a network of capillaries and a large **lymph vessel** called the **lacteal**.
- Mucosal epithelium has **goblet cells** which secrete mucus that help in lubrication.
- Mucosa also forms – glands in stomach (gastric glands)– Crypts of Lieberkuhn (crypts in between bases of villi in the intestine)
- All the four layers show modifications in different parts of the alimentary canal.

Differentiated into 3 parts –

(a) Outer- Muscularis mucosa.

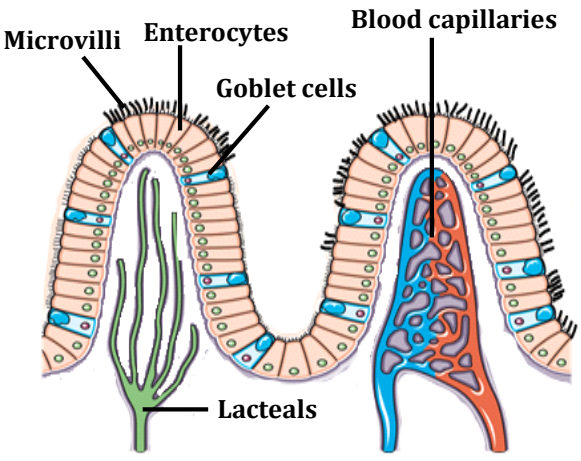
- **Outer** longitudinal layer and **Inner** circular layer.
- It has important role in exposing of surface area for the absorption.
- Provides support to the folds of alimentary canal.

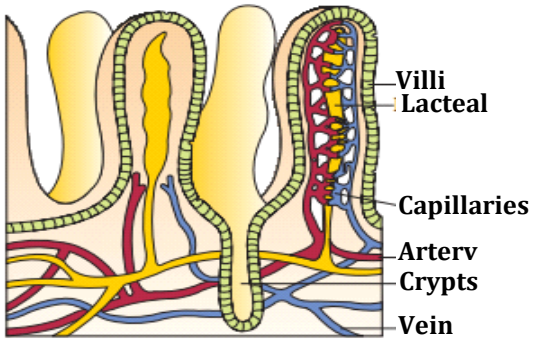
(b) Middle- Lamina propria (connective tissue layer)

- It contains blood and lymph vessels.
- It contains few modified lymphatic tissue which provides immunity i.e. **Peyer's patches (MALT)**.
- It is made up of reticular fibrous connective tissue (R.F.C.T.)
- It supports epithelium and binds it to the muscularis mucosa.

(c) Innermost- Mucosal epithelium (Mucosal layer)

- In **oesophagus** this layer is made up of non-keratinised stratified squamous epithelium.
- **Except oesophagus** this layer is single layer thick, which is made up of columnar mucous epithelium.
- This layer makes the lining of lumen of Alimentary canal.
- This layer makes the folds of alimentary canal.
- **Folds of oesophagus** are less developed.
- **Folds of stomach** are finger shaped and develop as gland called **gastric gland**.
- **Folds of small intestine** are conical shaped called **Villi**.
- Small slit like space is found at the base of villi. These spaces are called crypts of Lieberkuhn. Villi of duodenum are small blunt. Villi of Jejunum and Ileum are long and pointed. Maximum villi are found in Jejunum.





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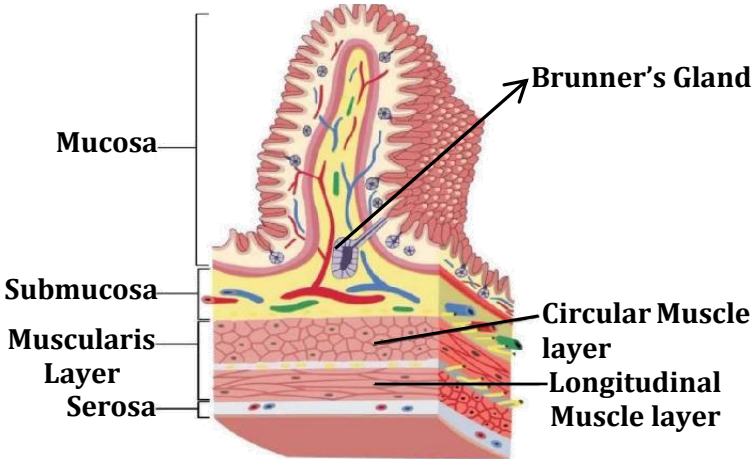
Brunner's gland :

- They are small spherical multicellular glands. They open into crypts of lieberkuhn with the help of fine tubules. These glands are found in the submucosa of duodenum. They synthesize and secrete the non-enzymatic alkaline secretion of intestinal juice.



Paneth cells :

- These cells are found in mucosal layer of crypts of Lieberkuhn of jejunum. They are unicellular glands. They synthesize and secrete Lysozyme and defensin. The secretory substances of Brunners glands and crypts of Lieberkuhn are combinedly called intestinal juice or succus entericus.

Peyer's patches :

- They are small lymph nodes which are found in the mucosa of small intestine (Jejunum and Ileum more in number).
- They are also called intestinal tonsils and provide immunity.

Nerve supply :

- Two types of Nerve plexus are found in muscle of alimentary canal.
- **Auerbach's Nerve plexus (myentric plexus)** this nerve plexus is found between longitudinal muscles and circular muscles, it control muscle contraction
- **Meissner's Nerve plexus** found between circular muscles and sub mucosa but in stomach it is found between oblique muscle & submucosa.

BEGINNER'S BOX-2 — HISTOLOGY OF ALIMENTARY CANAL

1. Peyer's patches produce-
(1) Enterokinase (2) Lymphocyte (3) Mucous (4) Trypsin

2. Duodenum has characteristic Brunner's glands which secrete –
(1) Estrogen (2) Prolactin, parathormone
(3) Estradiol, progesterone (4) Alkaline secretion

3. Brunner's gland are found in which of the following layers :
(1) Submucosa of stomach (2) Mucosa of ileum
(3) Submucosa of duodenum (4) Mucosa of oesophagus

4. The crypts of Lieberkuhn secrete :
(1) Gastrin (2) Rennin (3) Cholecystokinin (4) Succus entericus

5. In alimentary canal third histological layer from outside to inside is-
(1) mucosa (2) submucosa (3) serosa (4) muscularis

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6. Crypts of Lieberkuhn are present in :-
(1) Intestine (2) Stomach (3) Oesophagus (4) All of these

7. Out of four layers of alimentary canal, which one forms villi, (finger-like projection)?
(1) Serosa (2) Mucosa (3) Submucosa (4) Muscularis

8. Small finger-like projection, which produce numerous microscopic projections are supplied with a network of
(1) Blood capillaries and lacteal (2) Blood capillaries only
(3) Lacteal only (4) A large lymphoid vessel and valves

(C) Digestive Glands :

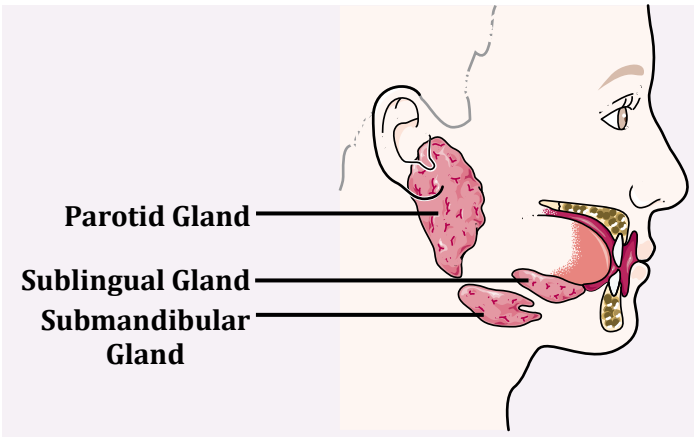
(1) Salivary Glands :

- Saliva is mainly produced by three pairs of salivary glands.

(i) **Parotids** (cheek)

(ii) **Sub maxillary / Sub mandibular** (lower jaw)

(iii) **Sub linguals** (below the tongue).
These glands are **situated outside the buccal cavity**, secrete salivary juice into the buccal cavity.



Salivary Glands: 3 Pairs				
		Parotid	**Submaxillary / Submandibular**	**Sublingual**
1.	Location	Below ear (cheek)	Jaw angle (lower jaw)	Below tongue
2.	Number	1 pair	1 pair	1 pair
3.	Duct	Stenson's duct	Wharton's duct (longest salivary duct)	Duct of Rivinus or Bartholin's duct (smallest salivary duct)
4.	Secretion	Saliva + Enzymes	Saliva	Saliva
5.	Special point	Largest salivary gland and viral infection cause Mumps.	Secrete maximum amount of saliva	Smallest salivary gland, Secrete minimum amount of saliva

Composition of saliva:

- Water-99.5 %
- **Ptyalin/Salivary amylase**
- Mucus
- Ions like Na^+, K^+, HCO_3^-, Cl^- etc.
- **IgA antibody**
- Urea and uric acid
- **Lysozyme** (Bacteriolytic enzyme)

- Thiocyanates

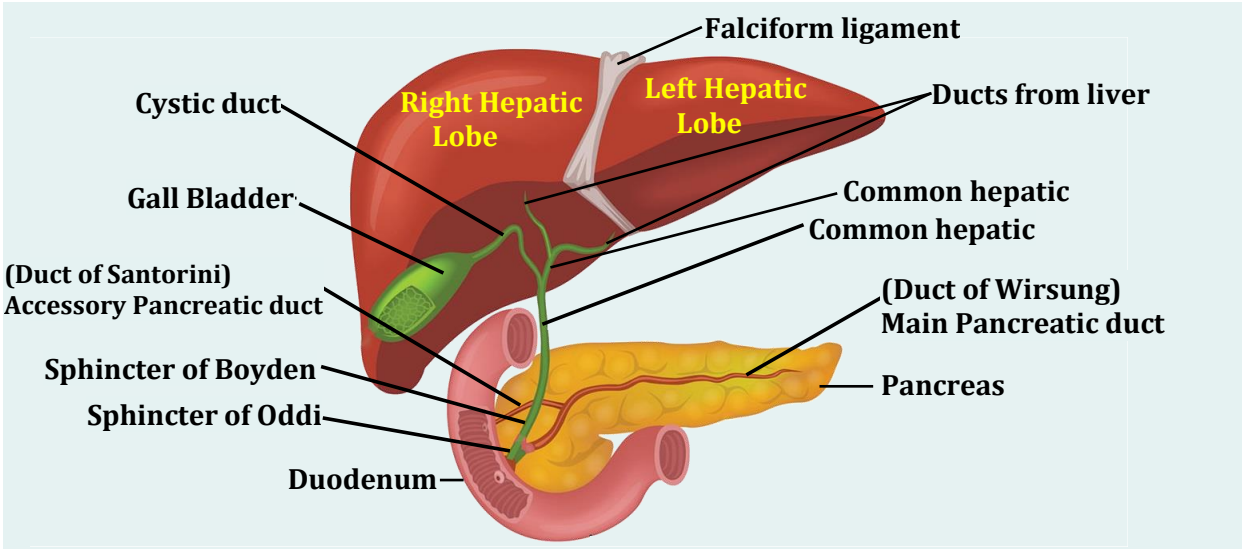
  - (Salivary amylase converts starch into maltose at pH 6.8)
  - Ptyalin (starch digesting) is secreted mainly by the parotid gland.
  - Lysozyme and Thiocyanates mainly kill bacteria. They also check the growth of bacteria in Bucco-pharyngeal cavity.

Salivation
|
Controlled by autonomic nervous system

Parasympathetic	Sympathetic
stimulate salivation	decreases salivation
(Feel, Taste of food)	**(Stress)**

(2) Liver :

- Largest gland of the body.
- It develops from endoderm.
- Weight 1.2 to 1.5 kg.
- It is situated in right side of abdominal cavity, just below the diaphragm.
- It is made up of **two lobes**, left and right lobe.
- Left lobe is smaller than right lobe. **Right lobe** forms 5/6 of the liver & **left lobe** forms 1/6 of liver.
- Right and left liver lobes are separate from each other by the **falciform ligament**, (Fibrous C.T.) which is made up of fold of peritoneum.



- The **hepatic lobules** are the **structural** and **functional units of liver** containing **hepatic cells** arranged in the form of **cords**.
- Each lobule is covered by a thin connective tissue sheath called the **Glisson's capsule**.
- Right and left hepatic duct develop from right and left liver lobe. Both these ducts combine to form a common hepatic duct.
- The **bile secreted by the hepatic cells** passes through the hepatic ducts and is **stored and concentrated** in a thin **muscular sac** called the **gall bladder**.
- The duct of gall bladder **(cystic duct) along with the hepatic** duct from the liver forms the **common bile duct.**

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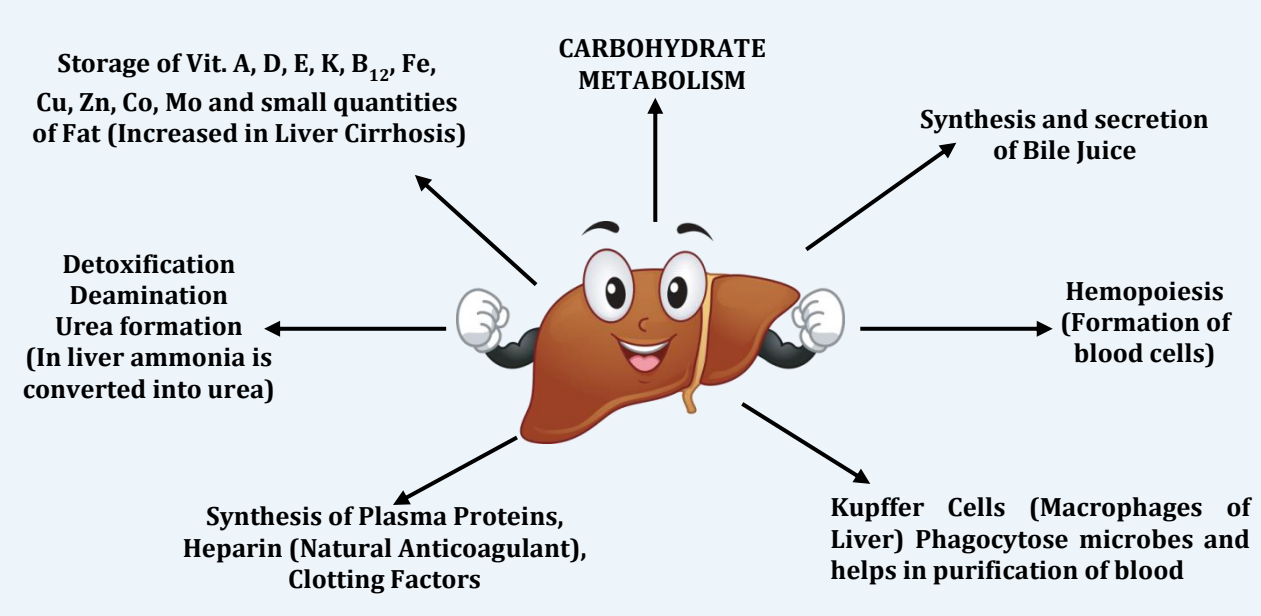
- The **bile duct** and the **pancreatic duct** open together into the duodenum as the **common hepato-pancreatic duct**, which is guarded by a sphincter called the **sphincter of Oddi**.

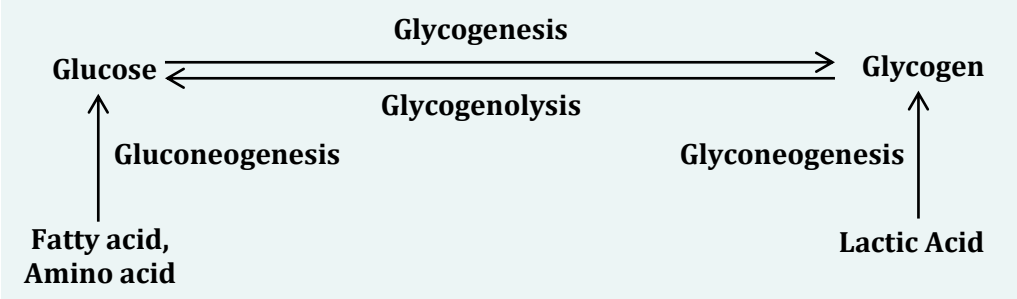
Gall Bladder :

- Gall bladder is situated below right lobe of liver.
- Cystic duct of gall bladder is connected to common hepatic duct to form a **common bile** duct **(Ductus choledocus)**.
- Gall bladder store and concentrate the bile juice.

Functions of Liver :


Storage of Vit. A, D, E, K, B_{12}, Fe, Cu, Zn, Co, Mo and small quantities of Fat (Increased in Liver Cirrhosis)
CARBOHYDRATE METABOLISM
Synthesis and secretion of Bile Juice
Detoxification
Deamination
Urea formation
(In liver ammonia is converted into urea)
Hemopoiesis (Formation of blood cells)
Synthesis of Plasma Proteins, Heparin (Natural Anticoagulant), Clotting Factors
Kupffer Cells (Macrophages of Liver) Phagocytose microbes and helps in purification of blood

Carbohydrate Metabolism :



Secretion & Synthesis of Bile :

- In the middle part of the duodenum bile-juice is secreted. The hepatocyte cells of the liver produce bile-juice and it is stored in the Gall- bladder. Bile-juice does not contain any digestive enzyme. Therefore, it is not a true digestive juice (Pseudo digestive juice).

Purification of Blood :

- Kupffer cells of liver & splenocytes of spleen are the phagocytic cells, helps in phago-cytosis of dead blood cells and bacteria from the blood.

Synthesis of Heparin :

- Heparin is a natural anticoagulant (mucopolysaccharide).
- Some heparin is also formed by basophills (granulated WBC) and mast cells.

Composition of Bile-juice :

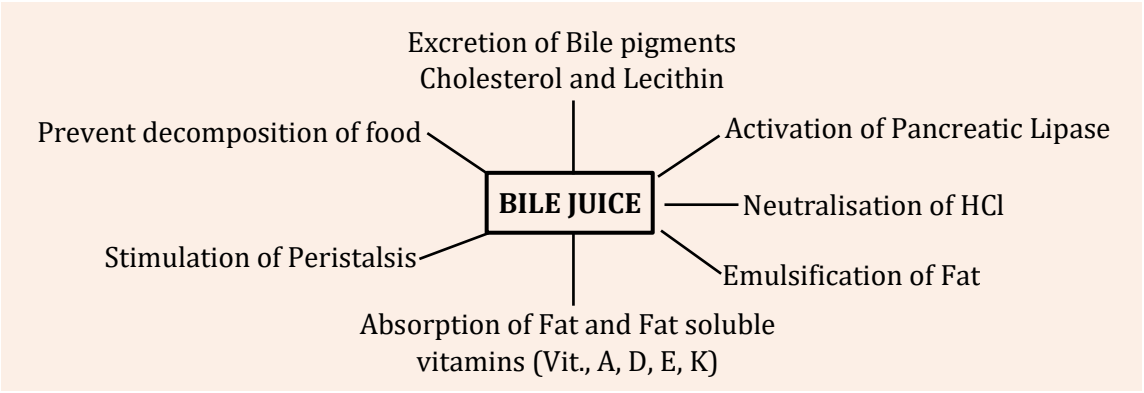
- pH 8.0 , H_2O 98% , organic constituents are bile acid , bile pigment, cholesterol, Lecithin, inorganic constituents Na^+, K^+, Cl^-, HCO_3^- , Bile-pigments are biliverdin and bilirubin. They are excretory products.

Bile-salts are of two types :

(a) **Inorganic- salts-** Bile-juice contains NaCl, Na_2CO_3, $NaHCO_3$ etc in it. Inorganic salts neutralize the acidity of the food and make the medium basic. It is necessary for the medium to become basic because the pancreatic-juices enzymes can act only in basic -medium.

(b) **Organic- salts-** Organic salts like Na-glycocholate and Na-taurocolate are found in Bile juice. The main function of these salts is the emulsification of fats because pancreatic Lipase can act only on emulsified fats.

Functions of bile :



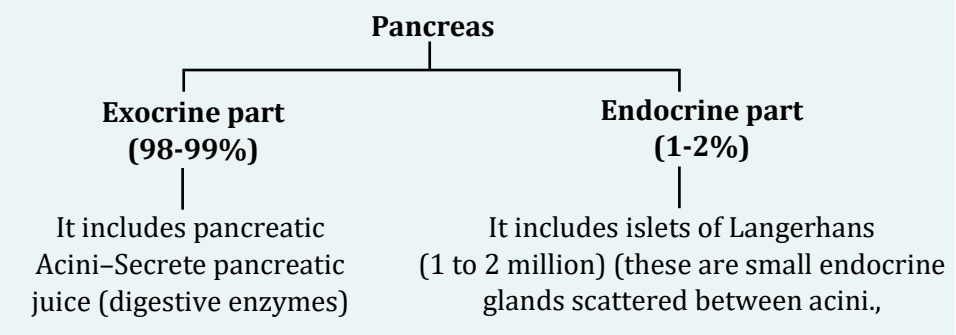
(3) Pancreas (Sweet Bread) :

Origin → Endodermal

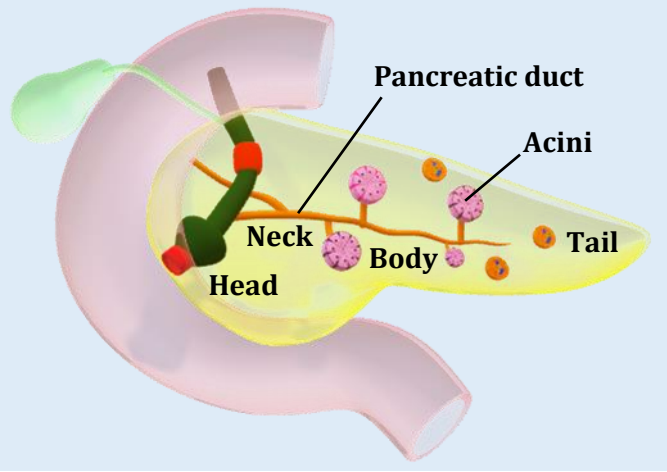
Position → Present at the loop of duodenum.

Pancreas is a soft, lobulated and elongated heterocrine gland.

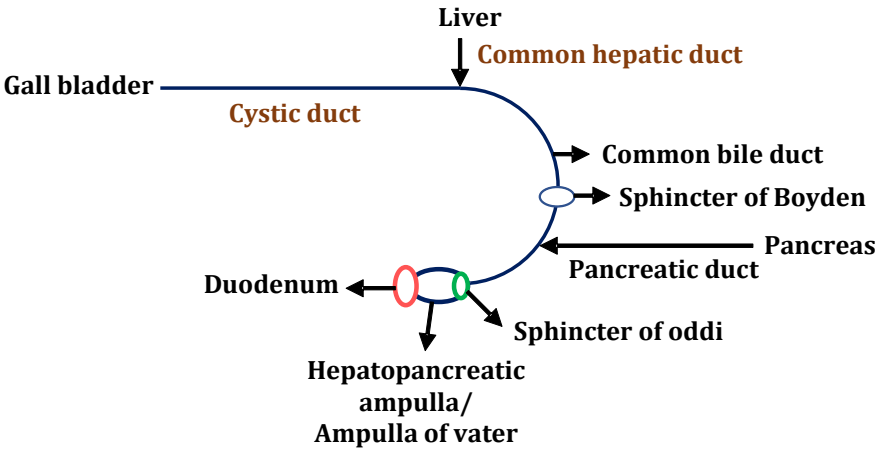
It is made up of two parts:-


Pancreas
Exocrine part
(98-99%)
Endocrine part
(1-2%)
It includes pancreatic Acini–Secrete pancreatic juice (digestive enzymes)
It includes islets of Langerhans (1 to 2 million) (these are small endocrine glands scattered between acini.,

- It is divided into head, neck, body, tail regions.



- Acini is a group of secretory cells surrounding a cavity. Each acini is lined by pyramidal shaped cells.
- Acini of Pancreas synthesise and secrete pancreatic juice.
- Islets of Langerhans synthesise and secrete hormones like glucagon and insulin.



- In humans both common bile duct and pancreatic duct combine to form common duct called as Hepato-Pancreatic duct. The terminal end of common duct is swollen and is called as **Ampulla of Vater or hepato pancreatic ampulla**. Ampulla of vater opens into middle part of duodenum and is controlled by sphincter of Oddi while bile duct is controlled by sphincter of Boyden.

Pancreatic juice :

- Pancreozymin stimulates the acini and glandular cells so pancreatic juice is secreted. The pancreatic juice is secreted by the exocrine cells of the pancreas. Pancreatic juice is highly odoriferous, colourless basic fluid which contains enzymes and salts.

Composition of pancreatic juice :

- Total amount in man = 1 litre to 1.5 litre/day,
- Water = 98%, pH = 7.5-8.3, Salts = 2%
- Pancreatic juice contains only inorganic-salts.

Enzymes :

- Pancreatic Amylase, Pancreatic Lipase, DNase, RNase and proenzymes like Trypsinogen, Chymotrypsinogen, Procarboxypeptidase.

BEGINNER'S BOX-3 DIGESTIVE GLANDS

1. Which of the following is the largest gland of our body?
(1) Liver (2) Pancreas (3) Salivary gland (4) Gastric glands

2. Ptyalin is secreted by _____ and work in _____ medium.
(1) Stomach, acidic
(2) Salivary gland, slightly acidic
(3) Pancreas, alkaline
(4) Bile, alkaline

3. Salivary gland with longest salivary duct is –
(1) parotid (2) sublingual
(3) submandibular (4) salivary glands are ductless glands

4. Which of the following is the smallest salivary gland?
(1) Parotid (2) Sublingual (3) Submandibular (4) All are equal in size

5. Salivary gland with smallest salivary duct is –
(1) parotid (2) sublingual
(3) submandibular (4) salivary glands are ductless glands

6. Which of the following is not the function of liver?
(1) Erythropoiesis (2) Synthesis of plasma proteins
(3) Digestion of carbohydrates (4) Storage of Vitamins like A and D

7. Liver is _____ in origin –
(1) ectodermal (2) endodermal
(3) mesodermal (4) ectomesodermal

8. Which of the following is the site of bile formation?
(1) Kidney (2) Liver (3) Intestine (4) Gall bladder

9. Which of the following is the site of concentration of bile juice?
(1) Gall bladder (2) Pancreas (3) Intestine (4) Liver

10. Which of the following is the function of pancreas?
(1) Erythropoiesis
(2) Synthesis of plasma proteins
(3) Secrete enzymes for digestion of carbohydrates
(4) Synthesis of bile juice

11. pH of pancreatic juice is -
(1) 7.5 to 8.3 (2) 8.3 to 9.3 (3) 3.0 to 4.5 (4) 4.5 to 6.5

12. The trypsinogen enzyme is secreted by –
(1) stomach (2) duodenum (3) pancreas (4) liver

13. Daily secretion of pancreatic juice is –
(1) 2 to 3 liter (2) 4 to 5 liter (3) 3 to 4 liter (4) 1 to 1.5 liter

14. Main pancreatic duct known as –
(1) duct of Santorini (2) duct of Wirsung (3) cystic duct (4) hepatic duct

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3. Physiology of Digestion :

- Digestion is divided in two ways-**Mechanical digestion** and **Chemical digestion**. Mechanical digestion takes place in mouth, stomach and small intestine.

(A) Digestion in Oral Cavity :

- Food enters through **mouth** food is tasted in **oral cavity** and mixed with **saliva**, **tongue** mixes the **food** with **saliva** and form **bolus**.

Mechanical digestion : In mouth teeth, tongue and lips have important role in mechanical digestion through the process of chewing or mastication.

Chemical digestion : In this type of digestion saliva mix with food particles.

Saliva contain **99.5% water** & **0.5% salts**.
These salts are organic and inorganic type.

Mucin :- It is a **glycoprotein**. It **lubricates** the food particles. It helps in the **swallowing of food**.

Bicarbonates present in saliva **neutralize** the acidity of food.

Lysozyme :- It is an enzyme which kills the harmful bacteria. Due to this reason saliva is a **antiseptic lotion**.

Thiocyanate: - It is a special salt which kills the harmful bacteria. So it is called **bacteriocidal salt**.

Ptyalin (Salivary amylase) : $\text{Starch} \xrightarrow[6.8\text{pH}]{\text{Ptyalin}} \text{Maltose}$

- Ptyalin is found in human saliva, because human food is mainly made up of starch.
- Ptyalin digest only ripe and cooked starch. It does not digest the raw starch, **30% starch** in buccal cavity is digested by **ptyalin**.

> Ptyalin is absent in saliva of rabbit and carnivorous animal, because food of rabbit is mainly made up of cellulose whereas carnivore food mainly contain proteins.

- Bolus is pushed inward through the pharynx into the oesophagus this process is called **swallowing** or **deglutition**. It is coordinated activity of tongue, soft palate, pharynx and oesophagus.
- The tongue blocks the mouth, part of soft palate and uvula close off the internal nasal opening nose and larynx rises so that **epiglottis** closes off the trachea food move downward into the oesophagus a travelling wave of constrictions called **peristalsis** pushes the Bolus (food) downward.
- Digestive enzymes are absent in Oesophagus but salivary amylase continue to function upto the last of Oesophagus. Wave-like muscular contractions called **Peristalsis** pushes the bolus downwards.
- The **cardiac sphincter/ Gastroesophageal sphincter** opens allowing the passage of bolus food to the stomach. Gastroesophageal sphincter normally remains closed and does not allow food contents of the stomach to move back.

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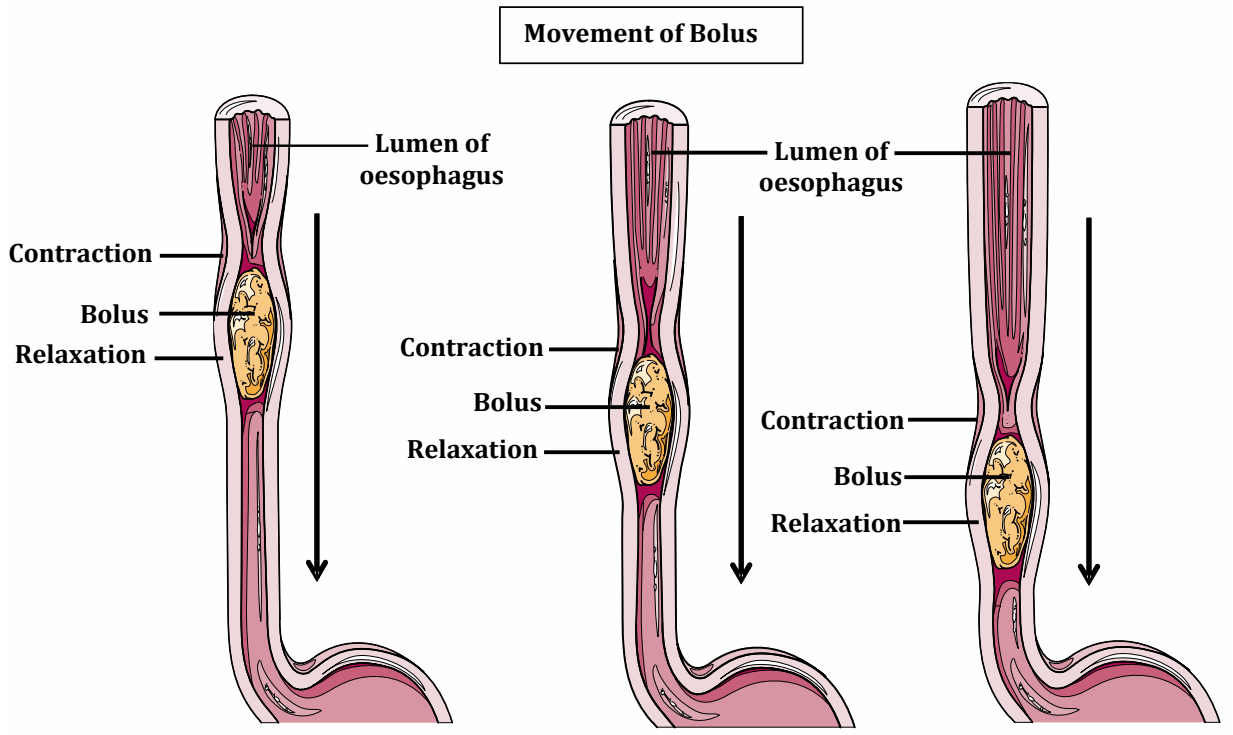
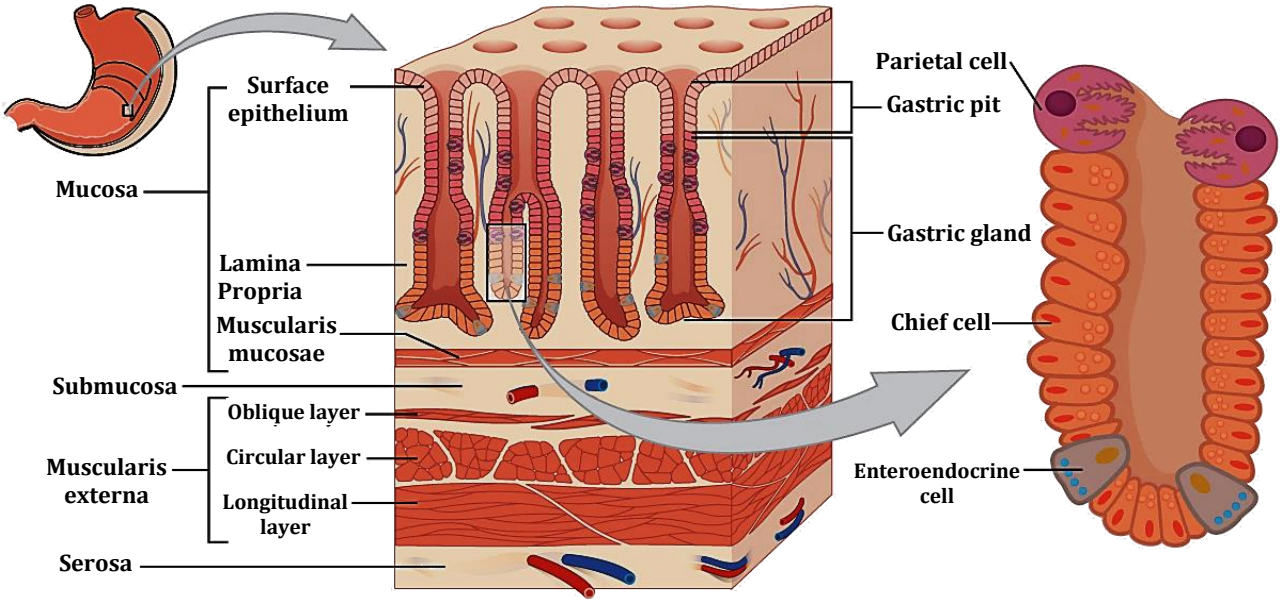


(B) Digestion in Stomach :

- The mucosa of stomach has gastric glands. Gastric glands have three major types of cells namely –
  (i) **Mucus neck cells** which secrete mucus;
  (ii) **Peptic, chief cells** or **zymogen cells** which secrete the proenzyme pepsinogen; and
  (iii) **Parietal** or **oxyntic cells** which secrete HCl and intrinsic factor (factor essential for absorption of vitamin B12).



- The stomach stores the food for **4-5 hours**. The food mixes thoroughly with the acidic gastric juice of the stomach by the churning movements of its muscular wall and is called the **chyme**.
- Gastric juice secretion is controlled by neural hormonal method and by chemical substances.

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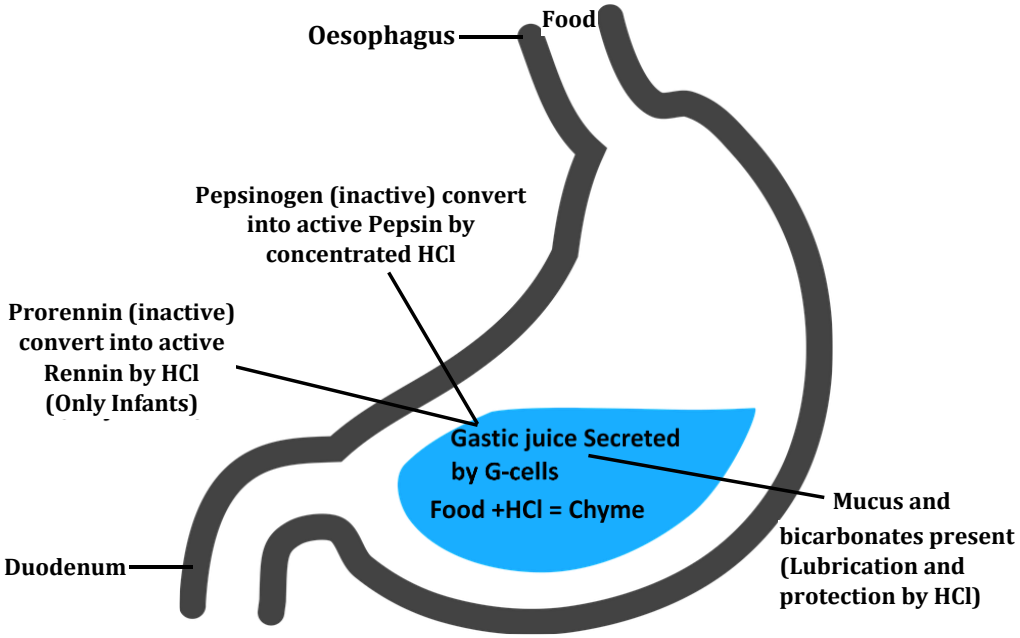
Composition of Gastric juice :

Secretion = 2000 ml to 3000 ml per day
Water = 99.5%
HCl = 0.2 - 0.3%
pH = 1.5 to 2.5 (very acidic)
Rest = Mucus and gastric enzymes (Pepsinogen, Prorennin, Gastric Lipase etc.).


Oesophagus
Food
Pepsinogen (inactive) convert into active Pepsin by concentrated HCl
Prorennin (inactive) convert into active Rennin by HCl (Only Infants)
Gastic juice Secreted by G-cells
Food +HCl = Chyme
Mucus and bicarbonates present (Lubrication and protection by HCl)
Duodenum

Functions of HCl :

1. The main function of HCl (activator) is to convert inactive enzymes (zymogens) into active enzymes.

$$\text{Pepsinogen} \xrightarrow{HCl} \text{Pepsin.}$$

$$\text{Prorennin} \xrightarrow{HCl} \text{Rennin.}$$

2. It destroys the bacteria present in the food.
3. HCl stops the action of saliva on food. In stomach, the medium is highly acidic.
4. It dissolves the hard portions of the food and makes it soft.

Digestion by Rennin (Chymosin) : Rennin is active in the childhood stage of mammals only.

$$\underset{\text{(milk protein)}}{\text{Casein}} \xrightarrow[\text{(chymosin)}]{\text{Rennin}} \text{Paracasein} \xrightarrow{Ca^{++}} \text{Ca-Paracaseinate}$$

- This process is termed as Curdling of milk. After becoming insoluble, milk can remain in the stomach for a longer time.

Digestion by pepsin :

$$\text{Pepsinogen} \xrightarrow{HCl} \text{Pepsin.}$$

$$\text{Proteins} \xrightarrow{\text{Pepsin}} \text{Peptones + Proteoses + Peptides}$$

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Digestion by gastric lipase :

$$1\%\text{ of Fats} \xrightarrow{\text{Gastric lipase}} \text{Fatty acid and Glycerol}$$

- This lipase acts on emulsified fat and convert it into fatty acid & glycerol. 1% emulsified fat is present in the food.
- Peristalsis continues during the process of digestion so the gastric juice mixes properly with the food. Due to peristalsis the food is converted into a paste. This form of food which is thick, acidic & semidigested in the stomach is called chyme.
- After short intervals, the pyloric orifice keeps on opening and closing so the chyme is fed into the intestine in instalments.

(C) Digestion of Food in Intestine :

(1) Small Intestine :

- In small intestine mechanical and chemical digestion occurs.
- Mechanical Digestion: Food reaches to different parts of alimentary canal by peristalsis.

Digestion in duodenum :

- **Biomacromolecules** are digested in duodenum.
- Chyme is mixed with bile juice, pancreatic juice and intestinal juice (succus entericus)
- Pancreatic amylase (Amylopsin) dissociates starch into Maltose. Majority of starch breaks up into the duodenum.

Digestion of starch : $\text{STARCH} \xrightarrow[\text{(Amylopsin)}]{\text{Pancreatic amylase}} \text{MALTOSE} + \alpha\text{–DEXTRIN}$

Digestion of protein:

- Enterokinase (endopeptidase) present in the Intestinal juice activates trypsinogen to active trypsin.
- Trypsin activates Chymotrypsinogen and procarboxypeptidase.

$$\text{Trypsinogen} \xrightarrow{\text{Enterokinase + } Ca^{++}} \text{Trypsin}$$

$$\text{Chymotrypsinogen} \xrightarrow{\text{Trypsin}} \text{Chymotrypsin}$$

$$\text{Procarboxypeptidase} \xrightarrow{\text{Trypsin}} \text{Carboxypeptidase}$$

$$\text{Proteins, Peptones and Proteoses} \xrightarrow[\text{carboxypeptidase + Amino acid}]{\text{Trypsin/Chymotrypsin}} \text{Dipeptides}$$

Fat digestive enzyme :

- In pancreatic-juices various Fat-digesting enzymes are found which are collectively called steapsin.
  - **(a) Pancreatic Lipase -** It converts triglyceride into monoglyceride, fatty acid, glycerol.
  - **(b) Cholesterol esterase -** It digests cholesterol esters. These esters are made up of cholesterol and fatty-acids Like- Lanolin, (cholesterol and Palmitic acid).
  - **(c) Phospholipase -** These digest phospholipids.

$$\text{Fats} \xrightarrow{\text{Lipase}} \text{Diglycerides} \xrightarrow{\text{Lipase}} \text{Monoglycerides}$$

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DNase and RNase - Digestion of DNA and RNA.

- In duodenum, digestion of biomacro molecules takes place in the presence of bile juice and pancreatic juice.

$$\text{DNA and RNA} \xrightarrow[\text{DNase and RNase}]{} \text{Nucleotides}$$

Digestion in jejunum and ileum :

- Some hormones like duocrinin, enterokinin stimulate the **crypts of Leiberkuhn** to secrete **succus-entericus** or **intestinal juice**. This succus entericus mainly contains water (99%) and digestive enzymes (<1%).
- Succus-entericus mainly contains the following enzymes-

Dipeptidase or Erepsin : This is a type of Exopeptidase. It converts oligopeptides into amino-acids.

$$\text{(Large peptide} \longrightarrow \text{Amino acids)}$$

Disaccharidases :

$$\text{Sucrose} \xrightarrow{\text{Sucrase (Invertase)}} \text{Glucose + Fructose}$$

$$\text{Maltose} \xrightarrow{\text{Maltase}} \text{Glucose + Glucose}$$

$$\text{Lactose} \xrightarrow{\text{Lactase}} \text{Glucose + Galactose}$$

Intestinal Lipase : $\text{Fats} \xrightarrow{\text{Lipase}} \text{Fatty-acids + Glycerol}$

Nucleotidase and Nucleosidase :

$$\text{Nucleotides} \xrightarrow{\text{Nucleotidase}} \text{Nucleosides + Phosphate}$$

$$\text{Nucleosides} \xrightarrow{\text{Nucleosidase}} \text{Pentose + Nitrogen base}$$

(2) Digestion in Large Intestine (Caecum) :

- In **herbivores**, the **symbiotic bacteria** and **protozoans** present in the caecum help in digestion of **cellulose** into glucose. So the digestion of cellulose takes place in caecum by the process of decomposition. This decomposition process is very slow. So very less amount of cellulose is digested at a time in caecum.
- In the last part of the large intestine faeces is temporarily stored.

Maximum digestion of food in Duodenum.
While digestion of food completes in Ileum.
Maximum absorption of food in Jejunum.

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BEGINNER'S BOX-4 DIGESTION OF FOOD

1. Carbohydrate digestion first starts in?
(1) buccal cavity (2) small Intestine (3) stomach (4) large Intestine

2. Amylase enzyme acts on the –
(1) starch (2) protein (3) fat (4) nucleic Acids

3. Mucin is a -
(1) glycoprotein (2) carbohydrate (3) lipid (4) glycolipid

4. It is an enzyme which kills the harmful bacteria. Due to this reason saliva is a antiseptic lotion. Identify the enzyme -
(1) lysozyme (2) mucin (3) ptyalin (4) lipase

5. Stomach stored food for .....
(1) 4 to 5 hours (2) 4 to 5 Minute (3) 2 to 3 hours (4) 6 to 7 hours

6. Pepsinogen is activated by –
(1) NaCl (2) Na_2CO_3 (3) HCl (4) KCl

7. Optimum pH for action of Ptyalin is-
(1) 8.0 (2) 7.6 (3) 6.8 (4) 5.0

8. Digestion of starch starts from the mouth, whereas ...A... is the site of digestion mainly for ...B... Choose the correct combination of options to complete the given statement.
(1) A-Stomach; B-Protein (2) A-Stomach; B-Starch
(3) A-Small intestine; B-Protein (4) A-Small intestine; B-Cellulose

9. Which enzyme works in highly acidic pH ?
(1) Pepsin (2) Lipase (3) Erepsin (4) Amylopsin

10. Gastric lipase acts on –
(1) proteins (2) carbohydrates (3) lipids (4) nucleic acids

11. Find the mismatch –
(1) HCl in stomach – pH = 5 to 7 (2) Mucus neck cells – secrete mucus
(3) Chief cells – secrete proenzymes (4) Oxyntic cells – secrete HCl

12. How much amount of gastric juice secrete daily?
(1) 2000 to 3000 ml (2) 4000 to 5000 ml (3) 1000 to 5000 ml (4) 1000 to 2000 ml

13. Bacteria entering with contaminated food are killed in stomach by -
(1) Pepsin (2) Renin (3) Sodium bicarbonate (4) HCl

14. Chymotrypsin is-
(1) Proteolytic enzyme (2) Secreted by stomach
(3) An enzyme but not protein (4) Nucleic acid digesting enzyme

15. Trypsinogen is an inactive enzyme secreted by the pancreas. It is activated by –
(1) pepsin of stomach (2) chymotrypsin
(3) bile (4) enterokinase

16. Which of the following secretions gets mixed with the food (hydrolysed) in the small intestine?
(1) Bile, pancreatic juices and intestinal juices
(2) Pancreatic juices, intestinal juices and gastric juices.
(3) Gastric juices, intestinal juices and bile
(4) Bile, gastric juices and salivary juices

17. Which part of alimentary canal responsible for digestion of cellulose in herbivorous?
(1) colon (2) jejunum (3) duodenum (4) caecum

18. Digestion complete in which part of alimentary canal?
(1) Ileum (2) Jejunum (3) Colon (4) Caecum

19. Maximum digestion occurs in –
(1) ileum (2) jejunum (3) duodenum (4) caecum

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(D) Regulation of Digestion :

- The activities of the gastro-intestinal tract are under neural and hormonal control for proper coordination of different parts. The sight, smell and/or the presence of food in the oral cavity can stimulate the secretion of saliva. Gastric and intestinal secretions are also, similarly, stimulated by neural signals.
- The muscular activities of different parts of the alimentary canal can also be moderated by neural mechanisms, both local and through CNS. Hormonal control of the secretion of digestive juices is carried out by the local hormones produced by the gastric and intestinal mucosa.

Role of some major gastrointestinal hormones

	Hormone	Source of secretion	Stimulus	Target/Action
1.	**Gastrin**	Pyloric stomach and duodenum (G-cells)	Vagus nerve activity; peptides and proteins in stomach.	Secretory cells and muscles of stomach; **secretion of HCl,** pepsinogen and stimulation of gastric motility.
2.	**Cholecystokinin (CCK)**	Duodenum (I-cells) or CCK cells	Food (fatty chyme and amino acids) in duodenum.	Gall bladder; contraction of gall bladder (bile release). **Secretion of pancreatic enzymes and bile juice**
3.	**Secretin**	Duodenum (S cells)	Food and strong acid in stomach and intestine.	**Secretion of water and bicarbonate** from pancreas inhibition of gastric motility. It stimulate liver for the secretion of bile juice
4.	**Gastric Inhibitory Peptide (GIP)**	Duodenum	Monosaccharides and fats (fatty chyme) in duodenum.	Gastric mucosa and muscles; **inhibition of gastric secretion and motility** (slowing food passage).
5.	**Duocrinin**	Duodenum	Acidic chyme	Stimulate Brunner's gland to secrete alkaline mucus.
6.	**Enterocrinin**	Duodenum		Stimulate paneth cells for synthesis and secretion of enzymatic part of intestinal juice.
7.	**Villikinin**	Duodenum		It stimulates the activity of villi.
8.	**Vasoactive intestinal peptide (VIP)**	Duodenum		They inhibits the motility of stomach
9.	**Enterogasterone**	Duodenum		Inhibit secretion of gastric glands

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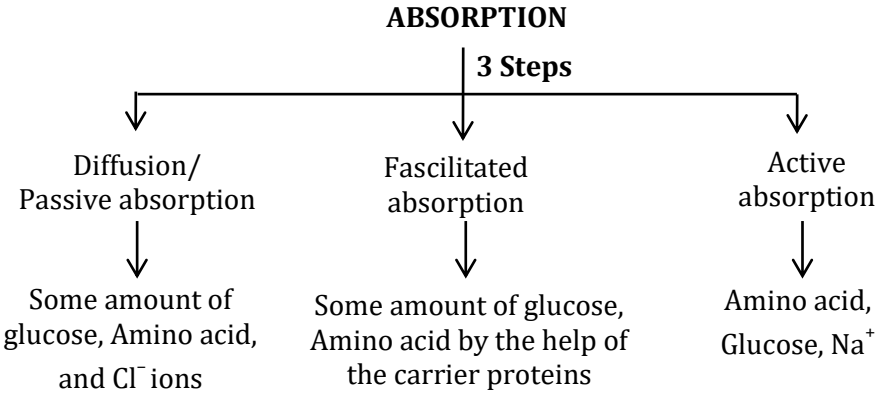
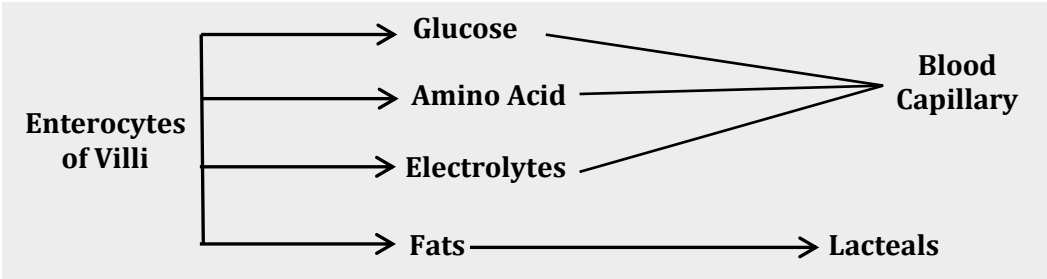
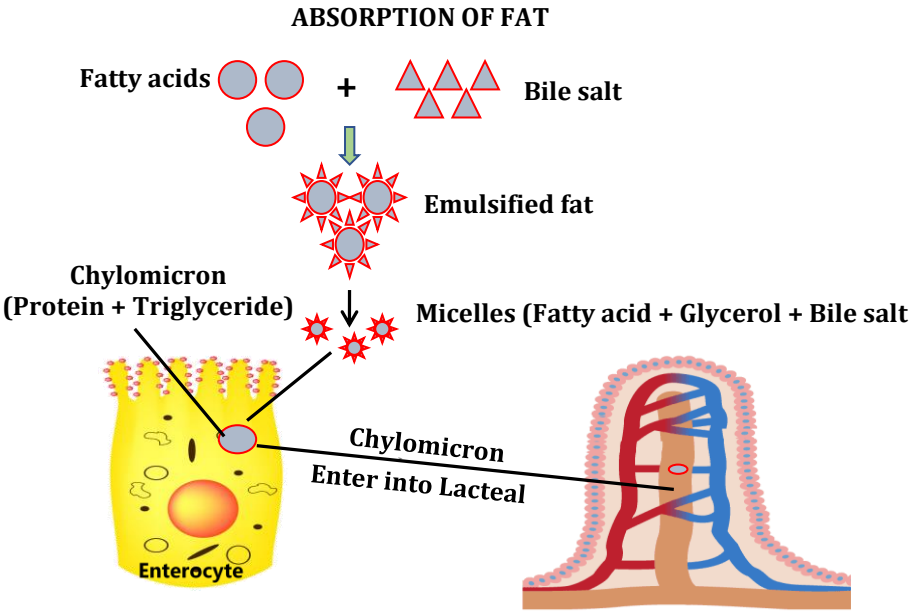
4. Absorption of Digested Food :


ABSORPTION
3 Steps
Diffusion/ Passive absorption
Some amount of glucose, Amino acid, and Cl^- ions
Fascilitated absorption
Some amount of glucose, Amino acid by the help of the carrier proteins
Active absorption
Amino acid, Glucose, Na^+

- **Absorption** is the process by which the end products of digestion pass through the intestinal mucosa into the blood or lymph. It is carried out by **passive**, **active** or **fascilitated** transport mechanisms.



- Small amounts of **monosaccharides** like glucose, amino acids and **some of electrolytes** like chloride ions are generally absorbed by **simple diffusion**. The passage of these substances into the blood depends upon the concentration gradients. However, **some substances like glucose** and **amino acids** are absorbed with the help of the carrier proteins. This mechanism is called the **fascilitated transport**.



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- Transport of water depends upon the osmotic gradient. Active transport occurs against the concentration gradient and hence requires energy. Various nutrients like amino acids, monosaccharides like glucose, electrolytes like Na+ are absorbed into the blood by this mechanism.
- Absorption of substances takes place in different parts of the alimentary canal, like mouth, stomach, small intestine and large intestine. However, maximum absorption occurs in the small intestine. A summary of absorption (sites of absorption and substances absorbed) is given in table.

Mouth	Stomach	Small Intestine	Large Intestine
Certain drugs coming in contact with the mucosa of mouth and lower side of the tongue are absorbed into the blood capillaries lining them.	Absorption of water, simple sugars, and alcohol etc. takes place.	Principal organ for absorption of nutrients. The digestion is completed here and the final products of digestion such as glucose, fructose, fatty acids, glycerol and amino acids are absorbed through the mucosa into the blood stream and lymph. Iron and calcium ions are absorbed proximal part of small intestine.	Absorption of water, some minerals and drugs takes place.

(A) Caloric Value :

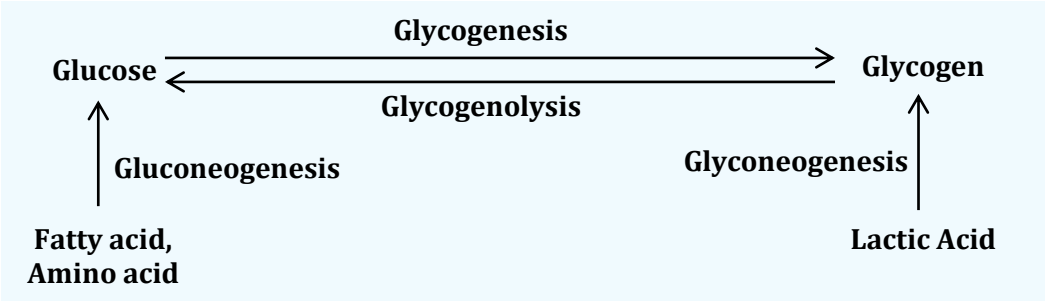
- The amount of heat liberated from complete combustion of 1 gm food in a bomb calorimeter (a closed metal chamber filled with O_2) is its **gross calorific value** or **gross energy value (G.C.V.)**.
- The actual amount of energy liberated in the human body due to combustion of 1 gm of food is the **physiologic value (P.V.) of food**.

NUTRIENT	GROSS CALORIFIC VALUE (in K.cal/gm)	PHYSIOLOGIC VALUE (in K.cal/gm)
CARBOHYDRATES	4.1	4.0
PROTEINS	5.65	4.0
FATS	9.45	9.0

(B) Assimilation of Food :

- The absorbed substances finally reach the tissues which utilise them for their activities. This process is called **assimilation**.

1. **Carbohydrates :**



2. **Proteins and amino acids :** Amino acids are not stored in body as they are highly reactive so converted into proteins which are building blocks of body.

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NH_3 is removed in this process and step is deamination. Deamination takes place in each and every cell of body but liver and kidney are chief sites of deamination.

3. **Fats -** Stored in body, help in insulation and thermoregulation.
Rich source of energy

4. **Minerals, water** and **vitamins** plays vital role in many vital processes of body.

(C) Egestion :

- The digestive wastes, solidified into **coherent faeces** in the rectum initiate a neural reflex causing an urge or desire for its removal. The **egestion** of faeces to the outside through the anal opening(defaecation) is a voluntary process and is carried out by a mass peristaltic movement.
- Faecal matter is yellowish brown in colour due to the presence of two pigments **(Stercobilin, Urobilin)**. These two are formed due to degradation of bile pigments. Foul smell in excreta is due to the presence of CH_4, NH_3, indole, scatole, tryphtophan and H_2S

BEGINNER'S BOX-5 — ABSORPTION OF DIGESTED FOOD

1. Amino acids are absorbed in-
(1) Blood capillaries of villi (2) Wall of rectum
(3) Lacteals and blood capillaries of villi (4) Lacteals of villi

2. Absorption of digested food chiefly occurs in-
(1) Stomach (2) Colon (3) Small Intestine (4) Large Intestine

3. Excess amino acids are deaminated & converted into urea in -
(1) Kidneys (2) liver (3) Spleen (4) Pancreas

4. _____ is the instant source of energy.
(1) Glucose (2) Fructose (3) Galactose (4) Maltose

5. Fats are absorbed in _____
(1) Lacteals in stomach (2) Lacteals in colon
(3) Lacteals in jejunum (4) Blood capillaries in duodenum

6. Removal of waste from body in the form of undigested food is called
(1) Digestion (2) Absorption (3) Assimilation (4) Egestion

7. Process of absorption of nutrients is carried out by
(1) Passive transport (2) Facilitated transport
(3) Active transport (4) All of the above

8. Absorption of glucose by –
(1) passive (2) facilitated (3) active (4) all of these

9. What is the site of amino acids absorption in human's small intestine?
(1) Duodenum (2) Jejunum (3) Ileum (4) Both (2) and (3)

10. Absorption of fat occurs through the process of
(1) Active transport (2) Facilitated transport
(3) Osmosis (4) Simple diffusion

11. Lacteals are associated with.
(1) secretion of lactic acid (2) absorption of fats
(3) production of milk (4) production of fat

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12. Maximum absorption of minerals and vitamins take place in –
(1) mouth (2) stomach (3) small intestine (4) large intestine

13. Maximum absorption of nutrients take place in –
(1) duodenum (2) jejunum (3) ileum (4) caecum

14. Which of the following is not the function of fats?
(1) Helps in insulation (2) Helps in thermoregulation
(3) Provide energy (4) Building blocks of our body

5. Disorders of Digestive System :

(A) Protein Energy Malnutrition (PEM) :

- Dietary deficiencies of proteins and total food calories are widespread in many underdeveloped countries of South and South-east Asia, South America, and West and Central Africa. Protein-energy malnutrition (PEM) may affect large sections of the population during drought, famine and political turmoil. This happened in Bangladesh during the liberation war and in Ethiopia during the severe drought in mid-eighties. PEM affects infants and children to produce **Marasmus** and **Kwashiorkar**.

Under weight child

Severely Emaciated child

- In both Kwashiorkor and Marasmus physical growth and mental development is affected.

Kwashiorkar	Marasmus
Occur in child **more than one year of age**	Occur in child **below one year**
Deficiency of proteins only	Deficiency of protein and calories both
Extensive oedema	No oedema, old man's face
Subcutaneous fat is still present	Subcutaneous fat disappears
Wasting of muscles and thining of limbs occur	Extreme emaciation of body and thinning of limbs occur
Skin appear to be swollen	Skin is dry and wrinkled
Underweight children	Severely emaciated

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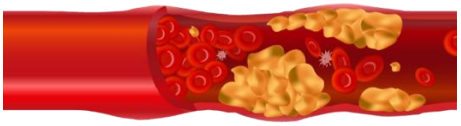
(B) Disorders of Alimentary Canal :

1. **Hypercholesterolemia (Overnutrition) –** It is caused due to intake of excess of saturated fat such as butter, ghee, red meat, egg. Cholesterol level in blood rises abnormally **(hypercholesterolemia)** this may cause thrombosis and heart attack.



2. **Obesity (Overnutrition) –** It is caused by excessive intake of high caloric nutrients such as sugar, honey and saturated fat.
   Fat accumulates in the tissue. This may cause high blood pressure, diabetes and heart diseases. Regular exercise and taking of green leafy vegetable are recommended to such persons.
3. **Jaundice -** The liver is affected skin and eyes turn yellow due to the deposit of bile pigments.
4. The inflammation of the intestinal tract is the most common ailment due to bacterial or viral infections. The infections are also caused by the parasites of the intestine like tape worm, round worm, thread worm, hook worm, pin worm, etc.
5. **Vomiting:** It is the ejection of stomach contents through the mouth. This reflex action is controlled by the vomit centre in the medulla. A feeling of nausea precedes vomiting.
6. **Diarrhoea:** The abnormal frequency of bowel movement and increased liquidity of the faecal discharge is known as diarrhoea. It reduces the absorption of food.
7. **Constipation:** In constipation, the faeces are retained within the colon as the bowel movements occur irregularly.
8. **Indigestion:** In this condition, the food is not properly digested leading to a feeling of fullness. The causes of indigestion are inadequate enzyme secretion, anxiety, food poisoning, over eating, and spicy food.

(C) Vitamins :

Earliest extracted vitamin = Vitamin - B_1

Vitamins are following types –

(a) Fat soluble vitamin : A, D, E, K

(b) Water soluble vitamin : B-complex and 'C'

Vitamin	Common name	Deficiency disease
A	Retinol	Nightblindness (Nyctalopia) Xeropthalmia, Dermatitis
B_1	Thiamine	Beri-beri/Polyneuritis/Cardio vascular atrophy
B_2	Riboflavin vitamin-G or Yellow Enzyme	Cheilosis, Glossitis, Keratitis
B_3	Niacin	Pellagra
B_9	Folic acid/Folate	Macrocytic anaemia
B_{12}	Cyano - Cobalamine	Pernicious anaemia
C	Ascorbic Acid	Scurvy, Anaemia, Joint pain, Collagen formation
D	Calciferol	Rickets in Children and Osteomalacia in Adults
E	Tocopherol/Antisterility/ Beauty Vitamin	Macrocytic Anaemia, Muscular dystrophy
K	Menadione/Phylloquinone	Severe bleeding

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BEGINNER'S BOX-6 DISORDERS

1. Vomit centre is located in :
(1) Medulla (2) Pons (3) Mid brain (4) Hypothalamus

2. Marasmus disease is caused due to :
(1) Protein deficiency (2) Obesity (3) Dwarfism (4) Deficiency of vitamins

3. Food is one of the basic requirement of all living organisms. The major component of our food are carbohydrates, proteins and fats. Food provides energy and organic materials for growth and repair of tissues. Deficiency of food will lead to protein energy malnutrition (PEM).
Which one of the following disease is characterized by PEM ?
(a) Marasmus with changes in hair (b) Kwashiorkar with wasted muscles
(c) Marasmus with old man's face (d) Marasmus with oedema.
(1) a, b (2) b, c (3) c, d (4) a, b, c

4. Balanced diet is diet rich in carbohydrates, mild in protein and low in fats with essential vitamins and minerals. Deficiency of proteins in diet of a children between age group of 1 to 3 will not lead of following symptoms.
(1) Wasted muscles (2) Oedema (3) Dwarfism (4) Prominent ribs

5. Match the Column I & Column II correctly :

Column I		Column II	
A	Marasmus	(i)	Itching rashes
B	Kwashiorkar	(ii)	Increase chance of thrombosis
		(iii)	Old man's face
		(iv)	Oedema

(1) A - (iii), B - (ii) (2) A - (iii), B - (iv) (3) A - (iii), B - (i) (4) A - (i), B - (iv)

6. The abnormal frequent movement of the bowl and increased liquidity of the faeces is called
(1) Vomiting (2) Indigestion (3) Constipation (4) Diarrhoea

7. The inflammation of intestinal tract is due to the infection of which microorganism?
(1) Bacteria (2) Virus (3) Mycoplasma (4) Both (1) and (2)

8. Which disease is not related with PEM?
(1) Kwashiorkar (2) Marasmas (3) Diarrhoea (4) Both (1) and (2)

9. In which disease the faeces are retained within the colon as the bowel movements occur irregularly?
(1) Constipation (2) Marasmas (3) Diarrhoea (4) Indigestion

10. In jaundice which body organ is affected?
(1) Stomach (2) Liver (3) Intestine (4) Oesophagus

11. Inadequate enzyme secretion, anxiety, food poisoning, over eating, and spicy food are related with-
(1) constipation (2) jaundice (3) diarrhoea (4) indigestion

12. Which disease is not related with overnutrition?
(1) Hypercholesterolemia (2) Jaundice
(3) Hypervitaminosis (4) Obesity

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BEGINNER'S BOX — ANSWERS KEY

BEGINNER'S BOX-1											
	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	1	1	2	4	1	3	1	1	1	3
	Que.	11	12	13	14	15	16	17	18	19	20
	Ans.	2	3	1	1	3	2	3	2	3	1

BEGINNER'S BOX-2									
	Que.	1	2	3	4	5	6	7	8
	Ans.	2	4	3	4	2	1	2	1

BEGINNER'S BOX-3											
	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	1	2	3	2	2	3	2	2	1	3
	Que.	11	12	13	14						
	Ans.	1	3	4	2						

BEGINNER'S BOX-4											
	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	1	1	1	1	1	3	3	1	1	3
	Que.	11	12	13	14	15	16	17	18	19	
	Ans.	1	1	4	1	4	1	4	1	3	

BEGINNER'S BOX-5											
	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	1	3	2	1	3	4	4	4	4	4
	Que.	11	12	13	14						
	Ans.	2	3	2	4						

BEGINNER'S BOX-6											
	Que.	1	2	3	4	5	6	7	8	9	10
	Ans.	1	1	2	4	2	4	4	3	1	2
	Que.	11	12								
	Ans.	4	2								

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ESSENCE

Summary of Digestive System

Duodenum, Jejunum, Ileum, Ascending, Transverse, Descending, Sigmoid

Mouth, Pharynx, Oesophagus, Stomach, Small intestine, Large intestine (colon), Rectum, Anal canal, Liver, Gall bladder, Pancreas, Salivaryglands

DIGESTIVE SYSTEM

Structure

Secretion for Digestion

NERVOUS SYSTEM

- Parasympathetic (Increases secretion of digestive juices)
- Sympathetic (Decreases secretion of digestive juices)

MECHANIC

- Mastication of food
- Peristalsis in oesophagus
- Gastric movements
- Intestinal Peristalsis

Salivary Secretion	Gastric Secretion	Pancreatic Secretion	Succus Entericus	Bile Secretion
Ptaylin	Pepsin	Chymotrypsinogen,	Dipeptidase	Emulsifiation of Fats
(Amylase)	Rennin	Trypsinogen,	Intestinal lipase	and Absorption of
	Gastric Lipase	Procarboxypeptidase,	Sucrase,	fat-soluble vitamins
	HCl	Amylase	Maltase,	Stimulation of peristalsis
		Pancreatic Lipase	Lactase,	
		Nucleases	Nucleotideses,	
		(DNase and RNase)	Nucleosidases	

SUMMARY OF ABSORPTION

Glucose	Glucose	Glucose
Cl^- → Simple Diffusion	Facilitated Transport	Active Transport ← Na^+
Amino acid	Amino acid	Amino acid